cessful in the majority of the patients. However, small residual shunts detectable by TEE are common.

954-137 An Analysis of the Outcome of Umbrella Closure of Patent Ductus Arteriosus in Children

M.H. El Habbal, W. Muniweera, J.F.N. Taylor. *Cardiac Unit, Great Ormond Street Hospital For Children NHS Trust, London, UK*

Recently, the management of catheter closure of patent ductus arteriosus (PDA) was changed from using umbrella device to coils. This change was based on the relative complexity and cost of the umbrella device. In the period from 1990 to 1996, 115 patients underwent catheter closure of PDA using umbrella device (130 devices). Their ages were 8 months to 18 years (median 4 years) and weights 8–51 kg (median 15 kg). All patients underwent cardiac catheterisation and angiography before and after implantation of the device/s. All were admitted to hospital; echocardiographic and doppler examinations were performed within 24 hours. In 3 cases, an initial attempt to implant coils failed and an umbrella device was used. Residual leakage was present in 34 cases (30%). This resolved spontaneously within 6–14 month in 26 cases. Re-intervention was required in 8 cases (7%); a second umbrella device was implanted in 6 cases and coils in 2 cases (6 coils were used). The complications were haemolysis due to significant leakage (1), mild narrowing of left pulmonary artery from a large device (2), embolisation of a small device into the right pulmonary artery requiring surgical retrieval (1), broken device (1), small device which was replaced by a larger one (6) and external bleeding (2). These complications occurred during our early experience. All patients (except one) were discharged 24–36 hours after admission. To date, no late complications have been encountered. *Conclusion:* The use of umbrella device can achieve 99% complete closure of patent ductus arteriosus by 14 months. Failure of coils to close large PDA warrants the use of umbrella device. Coils may be used for successful closure of residual shunts.

954-138 Outcome of Stent Implantation into the Arterial Duct in Cyanotic Neonates

E. Rosenthal, S.A. Qureshi, E.J. Baker, M. Tynan. *Paediatric Cardiology, Guy's Hospital, London, UK*

Stent implantation into the arterial duct (ST-AD) may avoid systemic to pulmonary artery shunt operations in neonates with duct-dependent cyanotic heart disease.

We have attempted ST-AD using 4–6 mm diameter Tower single strand retrievable stents 1.2–1.6 cm in length in 13 neonates and 1 infant (ages 2–46 days and weights 2.6–4.2 kg). Pulmonary atresia (PAt) was present in 8, severe subpulmonary stenosis in 5 and critical pulmonary stenosis (PS) in 1. In 4 patients (pts), balloon dilation (BD) of the pulmonary valve was performed (2 after radiofrequency valvotomy for PAt & IVS, 1 critical PS, 1 TOF).

It was not possible to place a guidewire across the tortuous duct in 4 pts: 3 of them proceeded to a modified Blalock-Taussig shunt and 1 had BD of the pulmonary outflow tract. 4 stents were malpositioned initially and 1 embolised into the pulmonary artery: these were snared, removed and replaced more accurately. 2 patients, in whom the aortic orifice of the duct had not been stented, remained duct dependent and required further stents at a second procedure. Aspirin and Warfarin were continued after the procedure.

1 pt died suddenly at 24 hours in ventricular fibrillation cause unknown and 1 pt died at 8 weeks from inadequate pulmonary blood flow. 2 pts required Blalock-Taussig shunts at 1 & 6 weeks. 2 pts with complex PAt had central pulmonary artery reconstruction at 12 & 16 months. 1 pt had complete TOF repair at 4 months. In 2 pts who were no longer duct dependent (1 critical PS and 1 with PAt & IVS) the stents occluded uneventfully at 9 and 25 months after Warfarin was discontinued. 1 pt with PAt & IVS is still duct dependent.

Stent implantation into the arterial duct is an alternative to neonatal systemic to pulmonary artery shunt operations. In some all surgery can be avoided; in others, subsequent surgery can be performed in the absence of a thoracotomy or pulmonary artery distortion.

954-139 Immediate Change in Right Ventricular End Diastolic Pressure After Pulmonary Valvuloplasty

W.B. Drake, T.P. Doyle, G.A. Moreau, T.P. Graham. *Vanderbilt University Medical Center, Nashville, TN, USA*

It is well known that percutaneous pulmonary balloon valvuloplasty results in an immediate decrease in peak right ventricular systolic pressure in patients with congenital valvar pulmonary stenosis. An immediate decrease in right ventricular end-diastolic pressure has been observed post-pulmonary valvuloplasty in some patients. This study retrospectively reviewed 56 patients who had pulmonary valvuloplasty performed in 58 procedures. In 21 of the 58 procedures, right ventriculograms were performed before and after valvuloplasty, giving additional volume data. Patients with volume data did not significantly differ from the total group in age at catheterization, severity of obstruction or improvement in gradient. As expected, differences were seen pre- and post-valvuloplasty in peak RV systolic pressure (mean pre = 98 mm Hg; mean post = 55 mm Hg; $P < 0.05$) and pulmonary valve gradient (mean pre = 74 mm Hg; mean post = 30 mm Hg; $P < 0.05$). A decrease in right-ventricular end-diastolic pressure was also seen (mean pre = 11.4 mm Hg; mean post = 10.0 mm Hg; $P < 0.05$) post-valvuloplasty. Additionally, an increase in angiographic ejection fraction was observed in the volume group (mean pre = 57.5%; mean post = 65.5%; $P < 0.05$). A significant difference was also seen in right ventricular end-systolic volume after valvuloplasty (mean pre = 14.4 mL/m^2; mean post 11.6 mL/m^2; $P < 0.05$) but not in right ventricular end-diastolic volume (mean pre = 35.7 mL/m^2; mean post = 33.6 mL/m^2; $P = 0.21$). In summary, there appears to be a small but significant immediate decrease in right ventricular end-diastolic pressure post pulmonary valvuloplasty which cannot be explained by changes in end-diastolic volume. This would suggest that changes in right ventricular distensibility can be an acute active process which may be dependent on ventricular afterload.

954-140 Pulmonary Balloon Valvuloplasty Induced Acute Changes in Right Coronary Blood Flow Velocity Pattern

I.E. Kallikazaros, C.G. Stratos, C.P. Tsioufis, C.I. Stefanadis, S.A. Marakas, P.K. Toutouzas. *Department of Cardiology, University of Athens, Greece*

The impact of the elevated right ventricular systolic pressure (RVSP) and its changes on the right coronary artery (RCA) blood flow have not been well studied in humans. In 7 patients with severe isolated pulmonary valve stenosis (mean age 28.6 ± 16.1 years), proximal RCA blood flow velocity (BFV) was measured, using an intracoronary Doppler velocimeter, along with hemodynamic parameters before and after pulmonary balloon valvuloplasty (PBV). The pre-valvuloplasty phasic RCA BFV pattern was predominantly diastolic with an obvious systolic retrograde wave. RVSP had a negative correlation with the peak systolic antegrade BFV and the systolic antegrade BFV curve area ($r = -0.690$, $r = -0.454$, respectively) and a positive correlation with the peak systolic retrograde BFV, the systolic retrograde BFV curve area and the peak diastolic BFV ($r = 0.986$, $r = 0.722$, $r = 0.560$, respectively). PBV caused a significant reduction in both the transvalvular pressure gradient ($p = 0.002$) and the RVSP ($p = 0.004$). The peak systolic antegrade BFV and the systolic antegrade BFV curve area increased significantly ($p = 0.023$, $p = 0.048$, respectively). The peak systolic retrograde BFV and the systolic retrograde BFV curve area decreased significantly ($p = 0.019$, $p = 0.038$, respectively). RVSP changes were negatively correlated with the changes in the peak systolic antegrade BFV and the systolic antegrade BFV curve area ($r = -0.743$, $r = -0.924$, respectively) and positively correlated with the changes in the peak systolic retrograde BFV, the systolic retrograde BFV curve area, the peak diastolic BFV and the diastolic BFV curve area ($r = 0.942$, $r = 0.805$, $r = 0.722$, $r = 0.392$, respectively). RCA BFV pattern is strongly dependent on the RVSP level and its changes after PBV. PBV-induced reduction in RVSP results in improvement of the RCA BFV pattern.

954-141 Critical Pulmonary Valve Stenosis in the Neonate: Initial Results & Followup Using an Umbilical Artery Snare Assisted Approach

H.S. Weber, G. Wizar. *Penn State University Childrens Hospital, Hershey, PA, USA*

Neonatal critical pulmonary valve stenosis (PS) is rare and these infants present with cyanosis secondary to inadequate antegrade pulmonary blood flow & right to left atrial shunting. Balloon valvuloplasty (BV) is effective although technically difficult with variable results, multiple balloons are usually necessary (gradational approach) and fluoroscopy exposure can be extensive. Since 1989, 13 neonates with critical PS (age: 3 ± 2 days; wt: 3.4 ± 0:5 kg) presented with cyanosis requiring PGE1. The first 3 neonates underwent gradational BV & in the subsequent 10, BV was performed using a transductal snare assisted umbilical artery approach to simplify the procedure (5 mm goose neck snare via a 4 F umbilical artery catheter). Initial echo demonstrated severe tricuspid valve insufficiency (100%), RV dilation/reduced function (79%), RV hypoplasia (21%), pulmonary valve gradient (57 ± 18 mmHg), estimated RV pressure (92 ± 20 mmHg) & pulmonary valve annulus dimension (8.3 ± 1.4 mm). Post valvuloplasty there was a significant decrease in RV pressure (92 ± 18 vs 49 ± 9 mmHg, $p < 0.001$) & RV/Aorta pressure ratio (1.5 ± 0.2 vs 0.8 ± 0.1, $p < 0.001$). The number of balloons utilized (3.3 ± 2.1 vs 1.2 ± 0.4, $p < 0.01$) & fluoroscopy time (95 ± 5 vs 33 ± 14 minutes, $p < 0.01$) was reduced using the snare approach. PGE1 was discontinued in all patients 3 ± 5 days post valvuloplasty without

MONDAY POSTER

mortlity or additional palliation. Hospitalization was 16 ± 17 days (range: 2–65) and saturation at discharge was 89 ± 4%. At latest followup (26 ± 21 months) the echo predicted pulmonary valve gradient (12 ± 15 mmHg) & estimated RV pressure (36 ± 11 mmHg) remains low & systemic saturation by pulse oximetry is > 95%. No additional procedures have been necessary. *Conclusions:* Balloon valvuloplasty is the treatment of choice for neonatal critical PS. The "snare assisted" approach facilitates the use of large diameter balloons, eliminates the need for a gradational approach & significantly reduces procedure time/fluoroscopy exposure.

954-142 Long-Term Results of Severe Pulmonic Stenosis with Initial Gradient ≥150 mm Hg Treated by Balloon Valvuloplasty

A.H. Friedman, F. Al-Fadley, S. Oufi, M. deMoor, O. Galal. *King Faisal Specialist Hospital, Riyadh, Saudi Arabia*

The long-term outcome of balloon valvuloplasty (BVP) in pediatric patients (pts) with severe pulmonic stenosis (SPS) with systolic peak to peak gradients ≥150 mm Hg is reported. Between 1985 and 1996, 26 of 291 pts who underwent BVP for pulmonic stenosis had such gradients at catheterization. Pts ranged in age from 8 mo to 16 yr (median 8.0 yrs). No serious complications occurred. RV systolic pressure decreased from 207 ± 35 to 102 ± 58 mm Hg ($p < 0.05$), peak to peak systolic gradient decreased from 182 ± 34 to 84 ± 57 mm Hg ($p < 0.05$), and RV end-diastolic pressure decreased from 13 ± 6 to 9 ± 5 mm Hg ($p < 0.05$) with BVP. The RV to LV pressure ratio decreased from 1.72 ± 0.45 to 0.86 ± 0.57 ($p < 0.05$). 15 of 26 pts had an atrial shunt, and their aortic saturation increased from 85 ± 13% to 93 ± 5% following BVP ($p < 0.05$).

Follow-up data was available for 20 of 26 pts for a mean of 40 ± 27 months. At the first follow-up visit (6.6 ± 3 mo post-BVP), the measured Doppler gradient across the pulmonary valve was 35 ± 22 mm Hg with a median of 28.5 mm Hg. The Doppler gradient obtained at the first follow-up visit remained unchanged, 24 ± 8 mm Hg, at the last follow-up visit in all pts.

In conclusion, BVP for SPS with extremely high transvalvar gradients is safe, effective and provides both immediate and long-term benefits to pts with SPS. There is immediate improvement in right ventricular diastolic compliance and an apparent lasting reduction in pulmonary stenosis to a mild level.

954-143 Restenosis Versus Late Diameter Increase After Balloon Angioplasty of Branch Pulmonary Artery Stenosis

W.A. Radtke, G. Bartolomaeus. *Medical University of South Carolina, Charleston, SC, USA*

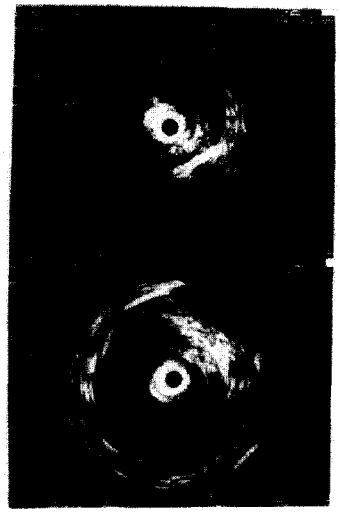
Vascular remodeling has been established as an important mechanism of restenosis or lack thereof after coronary angioplasty. We attempt to identify a similar response after angioplasty of pulmonary artery branch stenosis. Angiograms of 26 patients who underwent angioplasty of 36 lesions and had repeat angiography at follow-up interval of 2–64 months (mean 16.2) without other interim intervention were measured. Patients were 4.5 months–28 years (median 3.3 yrs) at the time of angioplasty. Sixty-nine percent had tetralogy of Fallot. A control group of 20 patients with similar diagnoses aged 16 months–15.1 years (median 3.6 yrs) with 10 normal and 21 stenotic vessels without angioplasty but with follow-up angiography after 4–76 months (mean 30.9) was measured. Stenosis diameter, location and diameters of adjacent normal vessel were measured before and after angioplasty and at follow-up, and recorded with all procedural parameters.

Acute diameter gain of > 50% was achieved in 58%. On follow-up, 16 lesions remained unchanged, 6 lesions had a late loss of > 20%, 1 and 12 lesions (35%) had a late gain of > 20% without aneurysm formation. These three distinct patterns of vascular response were independent of initial success or other factors (age, pulmonary artery pressure, location, balloon/stenosis ratio, absence or presence of intimal flaps, etc.). These response patterns remained, even if measurements were normalized to body surface area. In the late gain group, overall diameter increase was 125% compared to 41% initial increase. The net result was a long-term success rate of 58% despite restenosis in 32% after initial success. Late gain becomes even more significant if compared to the control group that showed no growth of untreated stenotic vessels which, normalized to body surface area, corresponds to diameter loss.

954-144 Trans-Balloon Intravascular Ultrasound During Balloon Dilation of Pulmonary Artery Stenoses and Aortic Coarctation

J.H. Stock, M.D. Reller, S. Sharma, D. Pavcnik, T. Shiota, D.J. Sahn. *Oregon Hlth Sci Univ, Portland, OR, USA*

Previously, intravascular ultrasound (IVUS) has been performed before and after balloon dilation of vascular stenoses to assess adequacy of angioplasty and the extent of dissection. We tested a 0.29 mm IVUS transducer-wire (Wise-Wire®, Meditech, Inc) which images from within commercially available balloon dilation catheters. *Methods:* 5 stenoses were surgically in 4 lambs (wt: 3.4–18.2 Kg) in the left pulmonary artery, and/or in the descending thoracic aorta. A PE-MT (Meditech, Inc.) 5 Fr. (8 mm × 3 cm) or an Accent 8 Fr. (10 mm × 4 cm) balloon dilation catheter was advanced over a guide wire to the stenotic area under fluoroscopic guidance. The IVUS wire was then placed in the guide lumen of the balloon catheter. IVUS images were recorded at 30 MHz on an HP SONOS 100 Intravascular Imaging System, before, during, and after dilation through balloons filled with debubbled, diluted Renografin®. *Results:* Trans-balloon imaging was helpful in verifying balloon location in the stenotic segment. Lumenal diameters by IVUS showed good correlation compared to angiography for 8 sites ($r = 0.81$). After successive balloon dilations, imaging during deflation allowed assessment of vascular elastic recoil, resultant lumen size and/or mural dissection (Fig. bottom) without moving the balloon.



Conclusions: This trans-balloon IVUS system provides assessment of stenosis pre, during and post dilation without the need for catheter changes; allowing for repeat dilation and potentially reducing the number of intraprocedural angiograms required.

954-145 Angioplasty for Post-Surgical Recurrent Coarctation of the Aorta in Infants Less Than One Year of Age

S. Maheshwari, E. Bruckheimer, J.T. Fahey, W.E. Hellenbrand. *Yale University, New Haven, CT, USA*

Balloon angioplasty [BA] for post-surgical recurrent coarctation of the aorta [CoA] was performed in 20 consecutive infants [12 male, 8 female] less than 1 year of age, between May 1986 and July 1994. Median age at surgery was 7 days [range, 1–35]. Surgical procedures included end-to-end anastomosis [11], subclavian flap [7] and Norwood [2]. BA was performed at a median age of 6.0 months [1.8–11] and weight of 6.1 kg [3.1–8.4] and was successful [peak gradient <20 mmHg] in 19 pts [95%]. Systolic peak pressure gradient decreased from 45.1 ± 22.5 to 8.1 ± 9.3 mmHg [$p < 0.001$]. Mean diameter of the CoA increased from 3.0 ± 1.0 to 5.4 ± 1.2 mm [$p < 0.001$]. Mean CoA-to-descending aorta diameter ratio increased from 0.38 ± 0.14 to 0.68 ± 0.15 [$p < 0.001$]. No acute aneurysms or other immediate complications occurred. Four pts required repeat BA [3 restenosis (gradient 23–60 mmHg), 1 residual CoA] at a mean interval of 7.7 mos. Repeat BA was successful in 3 pts. At median follow-up of 2.8 years [0.5–10] 17 pts were normotensive and had no clinical recoarctation [peak gradient <20 mmHg by BP measurement]. Two pts died of causes [sepsis, surgery] unrelated to CoA or BA and 1 pt had a residual gradient of 25 mmHg. One pt had an occluded femoral artery. There was no aneurysm formation in 13 pts by MRI or repeat angiography. Recurrent CoA is common in infants less than 1 year of age who undergo